

OBSERVATIONS ON SPHAGNUM FITZGERALDII

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Sphagnum fitzgeraldii Ren. & Card. is an infrequent peat moss, endemic to the southeastern Coastal Plain of the United States. It belongs to Section *Cuspidata* and bears resemblances to *S. cuspidatum* Ehrh. ex Hoffm., *S. trinitense* C. Müll. and *S. torreyanum* Sull. Little has been written about its biology, especially its ecology, phenology, distribution, and cytology. Some of these features are unique to the species and are not generally appreciated. I have had extensive field experience with *S. fitzgeraldii* extending over a period of more than thirty years, during which I have accumulated considerable information about it. This paper summarizes these observations.

It was my pleasure to introduce Howard Crum to this species on one of our many field excursions to the southeastern Coastal Plain and to discuss with him many of the singularities. It is highly appropriate, therefore, to dedicate this contribution to him.

TAXONOMY

Sphagnum fitzgeraldii is distinguished from its closest relatives by relatively short, ovate to oblong-elliptic branch leaves with the margins serrulate almost to the leaf bases by projecting cell ends. (The serrulations are not due to resorption of a portion of the border cells of the branch leaves, as in many *Sphagna*). Furthermore, the branch leaf apices, excepting those at the tips of the branches, are broadly truncate, generally with five or more teeth across the leaf apices. The ends of branches often end in a cluster of leaves with narrowly elongate apices, as in the three closest relatives listed above. Most of the confusion between *S. fitzgeraldii* and *S. trinitense*, both of which have serrulate branch leaf margins, seems to be due to a misreading of this character. The branch leaves of *S. cuspidatum* and *S. torreyanum* are entire, although some taxonomists allow slight serrulations at the very tips of the longer leaves at the ends of branches (e.g., Crum 1984).

Plants of *S. fitzgeraldii* are uniformly hemi-isophyllous. The stem leaves are mostly larger than the branch leaves, very concave, and entire-margined, except at the rounded apex. Like the branch leaves, they are also fibrillose and porose to the base.

The hyaline cells of the branch leaves have small ringed or unringed pores on both surfaces, often confined to the cell ends and occurring in threes at adjacent cell-angles. Some of the pores are faint and difficult to demonstrate without heavy staining.

Plants of *S. fitzgeraldii* are mostly smaller than those of its relatives and are lax and soft, especially when dry. A distinctive character is that the branches toward the tip of the capitulum end in prominent buds, which, in dried plants, are pointed and especially noticeable. This character is especially useful in field recognition if the truncate leaf tips cannot be seen.

HERBIER CARDOT

Sphagnum Fitzgeraldi Ren. et Card.
 Floride,
 sur le tronc et les feuilles pourries des palmiers.
 Leg. Fitzgerald.

FIG. 1. Copy of herbarium label from one of the three type collections of *Sphagnum fitzgeraldii* in PC.

The first published description of *S. fitzgeraldii* was attributed to Renauld ("in litt.") in the Lesquereux and James *Manual* (1884). The protologue is obviously a condensed translation of a description published a year later by Renauld and Cardot (1885), in which the citation reads, "*Sphagnum Fitzgeraldi* Ren. et. Card. Sp. nov. Lesquereux Manual, N. Am., p. 23." The type comprises three packets in the Cardot Herbarium (PC), one of which needs to be selected as the lectotype. I intend to do this as soon as I am able to examine the three specimens. They are obviously all from the same collection and each of the three labels specify "Ren. & Card." as authors of the "Spec. Nov." Through the courtesy of Dr. H el ene Bischler, a facsimile of one of the labels from the Cardot Herbarium is shown in FIG. 1. Clearly, Cardot was involved in studying and describing the new species. The omission of his name in the Lesquereux and James *Manual* is an error which has been passed along by Andrews (1913, 1940), Crum *et al.* (1965, 1973), Crum (1984), and Anderson (1990), among others. *Index Muscorum* (van der Wijk, *et al.* 1967) cited "Ren. & Card.," which, in my opinion, is the correct interpretation.

Renauld and Cardot (1885) incorrectly placed *S. fitzgeraldii* in Section *Hemitheca*, which Lindberg (Braithwaite 1878) erected for the single species, *S. pylaessii* Brid. Renauld and Cardot were misled, apparently, by the single collection of Fitzgerald's from Florida, the plants of which are mostly monopodial or forked ("... ses rameaux solitaires ou g emin s . . ."). The type collection very likely consisted mainly of juvenile plants regenerated from desiccated plants that had not yet produced capitula. According to the label (FIG. 1), the habitat was rotten leaves and stems of palms. Although not stated, most likely the regenerating plants came from a shallow depression (possibly in a hammock, based on the presence of palms) which had previously dried up.

Warnstorf (1911) clarified the relationship of *S. fitzgeraldii* by treating it as a variety of *S. trinitense*, which was a curious bit of conservatism from a renowned splitter. To compensate for this lapse, however, he described *Sphagnum trinitense* f. *immersum* and *S. mohrianum*, both of which are synonyms of *S. fitzgeraldii*, as Crum (1984) has pointed out. I should add that Crum prefers to treat *S. trinitense* as *S. cuspidatum* var. *serrulatum* (Schlieph.) Schlieph.

DISTRIBUTION

Sphagnum fitzgeraldii is restricted to central and northern Florida and a narrow strip of land near the ocean, extending along the Gulf of Mexico, from Jackson County, Mississippi, Alabama, the panhandle of Florida, Georgia, South Carolina, and north to Craven and Pamlico counties, North Carolina (FIG. 2). Why its range ends so abruptly here is puzzling. Repeated searches by many knowledgeable collectors, including Norton Miller, Howard Crum, Richard Andrus, Wolfgang Maass, Eric Karlin, and myself, in the northern coastal counties of North Carolina and southeastern Virginia have been unsuccessful in extending its range beyond that shown in the map (FIG. 2).

Crum (1984) reported *S. fitzgeraldii* from Santa Cruz, Gálapagos Islands, based on a specimen collected by D. Hunt, December 17, 1973, "Bellavista, on path to



FIG. 2. Map, showing the known distribution of *Sphagnum fitzgeraldii*.

summit of crater" (MICH). The specimen was originally identified as *S. cuspidatum* var. *serratum* (= *S. trinittense*) by A. LeRoy Andrews and later annotated by Howard Crum as *S. fitzgeraldii*. Through the courtesy of the latter, I have examined it recently and, I, too, find it puzzling. The plants have the soft texture of *S. fitzgeraldii* and the branch leaves are serrulate and somewhat truncate, but much less so than in *S. fitzgeraldii*. Also, the branch leaves are more straight-sided and much less ovate than in *S. fitzgeraldii*. The chlorophyllose cells of the branch leaves of the Galapagos specimen are triangular in section, barely exposed on the upper surface; in contrast, these cells are trapezoidal to rectangular in section in *S. fitzgeraldii*.

At my request, Crum recently reexamined the Galapagos specimen, and he now agrees that it is not that species (personal communication). The specimen is somewhat sparse and scrappy and neither of us is willing to assign a name to it. Possibly, it is an undescribed species, but better material is required before it can be dealt with satisfactorily.

ECOLOGY

Sphagnum fitzgeraldii occurs submerged or barely emergent in shallow pools, ditches, and other depressions that dry out completely for two or more months during the annual summer droughts characteristic of the southern United States. It may be found at the fluctuating margins of permanent water. Such margins are dry for most of the summer.

Sphagnum fitzgeraldii is principally a moss of disturbances; its habitats are strongly influenced by successional forces, principally fire and human activities. The vegetation of the southeastern Coastal Plain for a very long time has been shaped almost entirely by fire. Nearly all the native plants have a degree of fire resistance. Pines dominate because they are more resistant to fire than are hardwoods. Repeated fires kill back the hardwood seedlings and shrub understory. Succession is interrupted and pines continue to dominate, although fire keeps them thinned and spaced, opening up the canopy. In pine flatwoods where the winter water table is high enough, shallow depressions fill with water and provide suitable habitats for *S. fitzgeraldii*.

Pocosins are evergreen shrub bogs overtopped by scattered pocosin or pond pine (*Pinus serotina* Michx.). It is the only pine that can tolerate the high water table for long periods. It is also exceptionally resistant to fire. Even if the trunk is killed, numerous sucker shoots will emerge from the base. The understory consists of a thick, impenetrable tangle of evergreen shrubs, small trees, and vines. Unless there are openings, the interior of pocosins is too dense to permit much development of *Sphagna*. Fire and other disturbances, however, may open up enough space for the development of a genuine peat bog, although such bogs are not suitable habitats for *S. fitzgeraldii*, which apparently is unable to compete with more aggressive species.

The ecotone between pine flatwoods and pocosins is called savannah, which is composed of scattered, well-spaced pines, generally long-leaf (*P. palustris* Miller), slash (*P. elliotii* Engelm.), or, rarely, loblolly (*P. taeda* L.). Thus, a savannah always adjoins or encircles a pocosin. The ecotone between the two, especially the wetter side toward the pocosin, is a prime habitat for *S. fitzgeraldii*. It is often found at the shallow ends of roadside ditches through or along the margins of pocosins.

Even the smallest depressions can support this moss if they retain water during the winter growth period. I have collected it in deer tracks, as well as in human boot tracks in wet savannahs.

More or less open hardwood swamps also provide habitats. They are generally flooded during the winter months and dry in summer. I have seen a number of specimens from swamps from the panhandle of Florida, and farther south, in peninsular Florida, I have collected it from hammocks, which are small islands of more or less tropical vegetation surrounded by wetlands.

Several collections have been made from wet seeps, usually in sandy soil that dries up in summer. This type of habitat is not uncommon along some of the rolling sand ridges in the panhandle of Florida. On occasion I have observed thin, delicate sheets of *S. fitzgeraldii* along these seep lines.

PHENOLOGY

Most of the phenological information presented here was obtained from a single large colony of *S. fitzgeraldii* that Norton Miller and I discovered independently in Brunswick County, North Carolina, in 1973. It was the largest colony of this species that either of us has ever encountered. When we first observed this colony, the habitat was a shallow pool, scarcely more than 16 cm deep, but nearly 100 m long and from 10 to 15 m wide, created by soil removal for road maintenance. When first discovered, in February, the pool was almost completely filled with fruiting *S. fitzgeraldii*. Located in the ecotone between a wet savannah and a pocosin, the habitat was artificially maintained by a hunting club that kept vegetation cut back to foster quail populations. I have kept the site under observation until the present time.

Unfortunately, in the early 1980's, the club abandoned the site for hunting, and maintenance of the site ceased. Since then, the site has not burned, and invasion by pines (*Pinus serotina* Michx.), woody shrubs, and tall herbs have gradually replaced the moss. Succession in such areas is swift and, by the summer of 1991, *S. fitzgeraldii* had almost disappeared, presumably because of shading and competition from vascular plants. Only a few sparse clumps remained at that time.

Essentially all the vegetative growth in *S. fitzgeraldii* occurs in the winter and spring months when the shallow pools in which it grows are filled with water. In late May and June rainfall decreases, temperatures rise, evaporation increases and the shallow winter pools that support the moss gradually dry up. By mid-summer, most of the pools that support it are completely dry. If the summer drought is severe, the moss bleaches into relatively thin sheets and appears lifeless.

With the onset of late fall and winter rains, however, many of these seemingly lifeless plants regenerate from the younger stems and produce new plants directly, without forming protonemata. The new shoots are monopodial at first, but soon develop capitula, and by December, the new shoots are capable of producing sex organs. I have observed mature antheridia as early as December 15, and as late as February 2. Although, I have not been able to locate unfertilized archegonia, I have observed barely swollen capsules in late December and early January.

The earliest meiotic capsules I have observed were collected on February 2; the latest were taken on March 12. *Sphagnum fitzgeraldii* is dioicous and, as might be expected, it is not often found in fruit. During the approximately 10-year period

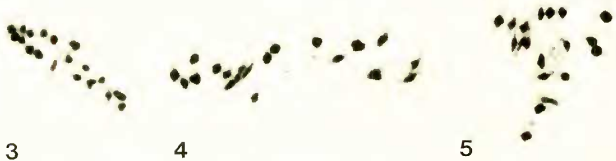
that the Brunswick County colony flourished, I found abundant capsules during seven of those years. In 1979 and 1980 only a few capsules were noticed. The largest crop of capsules occurred in 1981. During the successional period, beginning in 1982, when the colony began to diminish, capsule production was sparse and erratic, and I observed no capsules at this site after 1987.

Although, generally, plants of *S. fitzgeraldii* become heavily stressed during the summer droughts and regenerate when the shallow pools recharge with water in the fall months, I have observed colonies in Florida and North Carolina in which, apparently, plants were not stressed sufficiently during the summer to require regeneration. Growth continued terminally from shoots of the previous year by the usual forking procedure.

CYTOLOGY

The chromosome number of *S. fitzgeraldii* has not been published previously. Using essentially standard squash techniques (Anderson and Bryan 1987), the chromosome number, $n = 19 + 2m$, was established for the population discussed above (Shallow pool in an open, wet savannah, adjacent to a pocosin, 9.7 miles southeast of Supply, NC on Highway 211, Brunswick County, North Carolina; February 15, 1976; voucher, DUKE).

All species of *Sphagnum* thus far investigated have 19 or 39 bivalents at meiosis. In addition, a variable number of tiny, faintly staining *m*-chromosomes have been reported for various species (Fritsch 1982). In addition to the 19 regular bivalents observed in *S. fitzgeraldii*, two very faintly stained *m*-chromosomes are present. In most spore mother cells, the *m*'s are exceedingly difficult to distinguish (Fig. 3, for instance), but by intensive staining and careful squashing, they can be demonstrated (Figs. 4, 5). They are in Fig. 4 near the center of the metaphase plate, which has been spread out by squashing. One of the *m*-bivalents (to the right) has already disjoined into half-bivalents. In Fig. 5, the square-like configuration in the center consists of two sister chromatids to the right and a half-bivalent to the left not yet divided into sister chromatids. This precocious behavior indicates that they are probably achiasmate. Bryan (1955) has described the meiotic behavior of *m*-chromosomes in other species of *Sphagnum*. Their significance, if any, is still unknown.



FIGS. 3-5. Meiotic chromosomes of *Sphagnum fitzgeraldii*, $\times 3430$. 3. Prometaphase, showing 19 bivalents. *M*-chromosomes are not stained. 4. Heavily stained early metaphase, showing, at the center, one *m*-bivalent and two disjoined *m*-half-bivalents. 5. Similar, except the *m*-bivalent toward the center has disjoined into a half-bivalent and two half-chromatids; the second *m*-bivalent below has disjoined into two half-bivalents.

DISCUSSION

It is apparent that the life history and ecology of *S. fitzgeraldii* are meshed. Its growth and reproduction occur during the wet winter months when the small pools in which it grows are filled with water. Its ability to withstand extreme desiccation and to recover relatively quickly through direct regeneration without going through a time-consuming protonematal stage enables it to occupy habitats that dry out for long periods during the summer. It is largely restricted to these habitats because it manifestly cannot compete successfully with *S. cuspidatum* and *S. trinitense* in pools and ditches in which water is more or less permanent, or at least is not dry for long periods.

The rarity of *S. fitzgeraldii* is doubtless related to its narrow habitat restriction. It is unable to compete successfully with *S. cuspidatum*, *S. trinitense*, *S. torreyanum*, and the two varieties of *S. macrophyllum* Brid. in permanent water habitats. Its life history and its resistance to desiccation enables it to survive in shallow and more or less temporary depressions, pools, ditches, etc. Such habitats are easily altered by successional shifts so that its existence is usually precarious. Human disturbances, such as roadside ditches, and telephone and electric transmission lines through and alongside wetlands, have provided additional habitats. On the other hand, extensive drainage operations are drastically reducing habitats by severely lowering water tables in many areas where *S. fitzgeraldii* might grow. It is not by any means an endangered species, but, like other wetland species, there is a threat hanging over it.

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